2002 Progress Report

Acoustic Inventory and Monitoring of Bats at National Parks in the San Francisco Bay Area

Gary M. Fellers
Western Ecological Research Center, USGS
Point Reyes National Seashore
Point Reyes, CA 94956

February 24, 2003

The bat monitoring program is designed to collect data on the presence of bats in National Park Service (NPS)areas in the San Francisco Bay Area. In 2002, this included Point Reyes National Seashore, Golden Gate National Recreation Area, Eugene O'Neill National Historic Park, and John Muir National Historic Site. In addition to creating a species list, data will be analyzed to evaluate bat activity throughout each night, as well as on each night throughout the year. By comparing data from several monitoring stations, it will be possible to look for trends related to habitat, location within a park, and regional patterns throughout the bay area parks.

Acoustic Monitoring Stations

The first long-term bat monitoring station was setup in December 1999 at the Bear Valley headquarters of Point Reyes National Seashore. It has been in continual operation ever since. In 2002, nine additional bat monitoring stations were installed. One monitoring station was setup in each of three additional park areas: Eugene O'Neill NHS, John Muir NHS, and Golden Gate

NRA (Wilkins Ranch). Six new monitoring stations were added to Point Reyes NS.

All monitoring stations were setup in buildings with 110v power. This power supply allowed for more reliable operation of the monitoring equipment, and the buildings provided a secure location. Whenever possible, bat monitoring stations were chosen *so* they were near apparently good bat habitat, and also near **a** source of water that bats might use (e.g. pond, small stream).

Bat vocalizations are detected using an Anabat bat detector (Fig. 1). Each bat detector is adjusted to a standardized signal *so* sensitivity between detectors is identical. Vocalizations are stored on a portable computer hard drive. Figures 2-6 show some of the monitoring stations, illustrating typical placements of bat detectors and the surrounding habitat.

There were some unexpected problems during the first year of operation. The Dell computers have a power plug that is easily dislodged, thus allowing the computer to run down the battery and quit functioning. Steps were taken to tape the plugs in place, and the computers subsequently worked more reliably. The IBM portable computers tended to run hot. This was probably caused by the power management software. This software runs under Windows and controls the cooling fans. The bat monitoring software requires that the computers run in DOS mode. Hence, the cooling fans did not operate normally and the computers periodically shut down due to overheating. While this did not damage any equipment, it did result in less data from certain sites. Ways to alleviate the cooling problem are being explored.

Identification of Calls

The Anabat bat detector records ultrasonic sounds and lowers them into a frequency range that can 1)he heard by the human ear, and 2) can be conveniently stored on a computer hard drive. The Analook software displays these sounds in **a** graphic format that is similar to a sonogram that is typically used for analysis of bird vocalizations (e.g. frequency versus time). The typical call of a Mexican free-tailed bat is shown in Figure 7. Typical of most bat calls, each vocalization sweeps down in frequency (pitch). The slope of this sweep, and the lowest frequency are important features that assist in identification of bat vocalizations.

Since each call is separated by a longer period of silence (during which time the bat is listening for echoes), it is convenient to display bat vocalizations with the intervening "dead space" removed *so* that the display is a closely spaced series of calls. Figure 8 shows the same bat call with the time between each vocalization removed; this also results in more calls in the sequence being displayed. The calls of this species are characterized by a relatively low frequency and a fairly flat slope.

The calls of silver-haired bats (Fig. 9) and big brown bat (Fig. 10) are quite different. The figure legends point out some of the diagnostic features. Not all bat calls are *so* distinct, and the characteristics of a call can change a great deal, depending on what the bat is doing. For example, an individual bat will tend to produce lower pitched calls that sweep through a small range of frequencies when the bat is flying in the open. If the bat flies through the more cluttered understory of a forest, the calls increase in pitch, tend to sweep through a wider range of frequencies, and occur more frequently. All these changes function to provide the bat with more information about the environment in which it is flying. Calls also change when a bat detects a flying insect.

The variability in vocalizations within each species means that not all calls are easily assignable to one species. The prototype software (being developed by Chris Corben as part of this project) examines 8-10 features of each call and compares the characteristics to those of calls from known species of bats. Calls that are a close match are assigned to a particular species. We use fairly conservative criteria *so* that we have a high level of confidence that a call assigned to a given species is correct. As we refine our species-specific filters, we should be able to assign more calls to particular bat species.

Results

Table 1 shows the number of calls recorded at each of the 11 bat monitoring stations during 2002, and Figure 11 shows the same results graphically. Figures 12 – 16 show similar data for several species of bats.

There are some large differences between monitoring sites. These differences are likely due to 1) the number of individual bats in the vicinity of the detector, and 2) the activity of a few bats that might be foraging (e.g. flying back and forth) in the vicinity of the detector. There are known bat roosts in the vicinity of the detector at the Environmental Education Center, the Point Reyes Bird Observatory (PRBO), and the Wilkins Ranch. Interestingly, there is almost certainly not a roost in the vicinity of the detector at Olema Marsh, one of the sites where a fairly large number of bats were detected.

The fewest calls/day were recorded at the North District Office Center (NDOC) and at Eugene O'Neill NHS. The low number of bats at NDOC would be expected since it is out on the Point Reyes Peninsula in an area where there is more wind and cooler temperatures compared with the other Point Reyes monitoring sites. The low numbers of bats recorded at Eugene O'Neill is surprising since the detector is only about 100 yards from a large pond on the adjacent open space property.

Table 2 shows the species of bats detected at each of the 11 monitoring sites. Some bats were detected at all stations, e.g. Mexican free-tailed bat, red bat, hoary bat. Two of the most common bats in the San Francisco area (California myotis and Yuma myotis) are somewhat difficult to distinguish acoustically, so they are lumped together in the first column. This species pair was detected at all 11 sites. It is likely that we will be able to sort out the calls of these two species as we further develop and refine our call filters.

One moderately uncommon bat (long-eared myotis) that we thought might be in the area was not detected anywhere. The other species listed in the table were found in some, but not all sites. It is likely that the number of species detected at each site will increase as monitoring continues.

Work for 2003

Bat monitoring stations will be maintained through *2003 so* that additional data can be collected on both bat activity and species diversity. Newly available equipment is being tested to see if monitoring stations can become more reliable by replacing computers with small units housing compact flash cards. Call filters are being refined *so* that more calls can be classified at the species level. **As** this is achieved, past data will be reanalyzed as well as utilizing the refined filters for *2003* data.

Additional sites in Golden Gate NRA may be established if appropriate environmental clearance can be obtained.

Table 1. Number of bat calls detected at each of the 11 monitoring sites in 2002.

	Days	Calls	Calls/Day
Bear Valley	354	277,989	785.3
Ed Center	141	1,065,861	7,559.3
Eugene O'Neill	86	18,104	210.5
John Muir	166	126,652	763.0
Learning Center	159	49,340	310.3
NDOC	147	30,536	207.7
Olema Marsh	107	219,707	2,053.3
PRBO	228	608,249	2,667.8
PRNSA	48	15,645	325.9
Shallow Beach	121	91,865	759.2
Wilkins Ranch	186	330,302	1,775.8

Table 2. Species of bats detected at each of 11 sites monitored during 2002.

		Myotis californicus or Myotis yumanensis	Myotis yumanensis	Myotis lucifugus	Myotis evotis	Myotis thysanodes	Eptesicus fuscus	Lasionycteris noctivagans	Lasiurus blossevillii	Lasiurus cinereus	Tadarida brasiliensis
	Days in Operation	California or Yuma Myotis	Yuma Myotis	Little Brown Myotis	Long-eared Myotis	Fringed Myotis	Big Brown Bat	Siler-haired Bat	Red Bat	Hoary Bat	Mexican Free-tailed bat
Bear Valley	354	Y	Y	Y	N	Y	Y	Y	Y	Y	Y
Ed Center	141	Y	Y	Y	N	Y	Y	Y	Y	Y	Y
Eugene O'Neill	86	Y	Y	Y	N	Y	N	N	Y	Y	Y
John Muir	166	Y	Y	Y	N	Y	Y	Y	Y	Y	Y
Learning Center	159	Y	Y	N	N	Y	Y	Y	Y	Y	Y
NDOC	147	Y	Y	Y	N	Y	Y	Y	Y	Y	Y
Olema Marsh	107	Y	Y	Y	N	Y	Y	Y	Y	Y	Y
PRBO	228	Y	Y	Y	N	N	Y	Y	Y	Y	Y
PRNSA	48	Y	N	N	N	N	Y	Y	Y	Y	Y
Shallow Beach	121	Y	Y	Y	N	Y	Y	Y	Y	Y	Y
Wilkins Ranch	186	Y	Y	Y	N	Y	Y	Y	Y	Y	Y

Figure 1. Anabat bat detector inside a waterproof box, ready to mount. A multistrand wire is used to power to the detector and to bring the signal back to a computer inside the building.

Figure 2. Location of the bat detector at Bear Valley, Point Reyes National Seashore. The bat detector is located adjacent to the lower eve that covers the steps at the far end of the building.

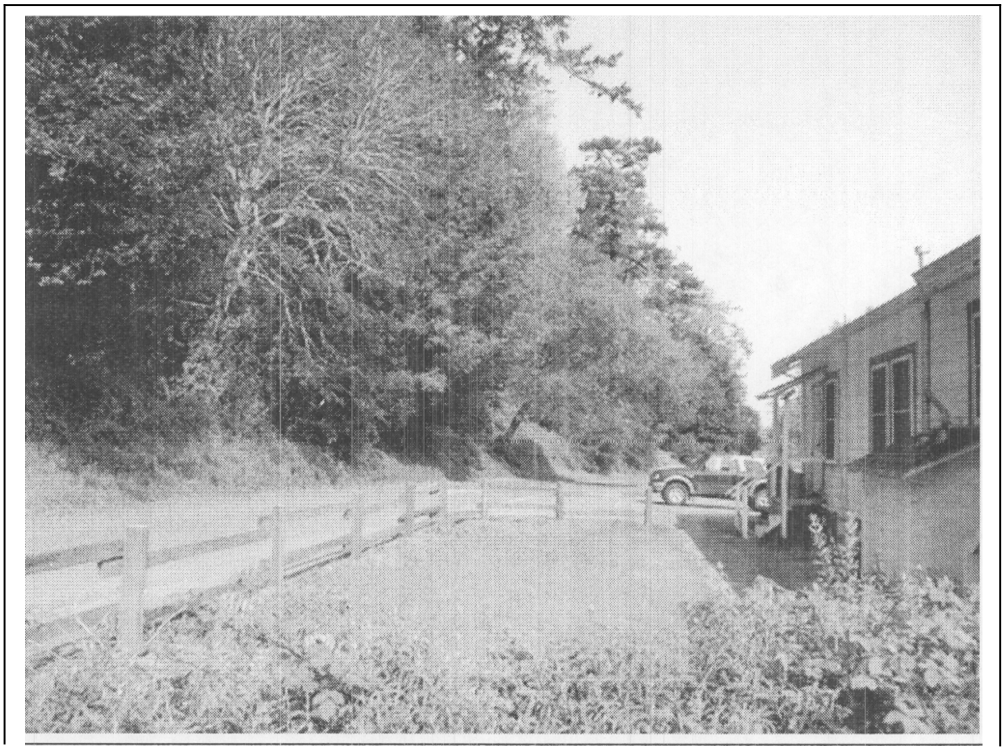

Figure 3. Location of bat detector at the North District Operations Center (NDOC), Point Reyes National Seashore. The detector is mounted at the lower edge of the second floor window on the far right.

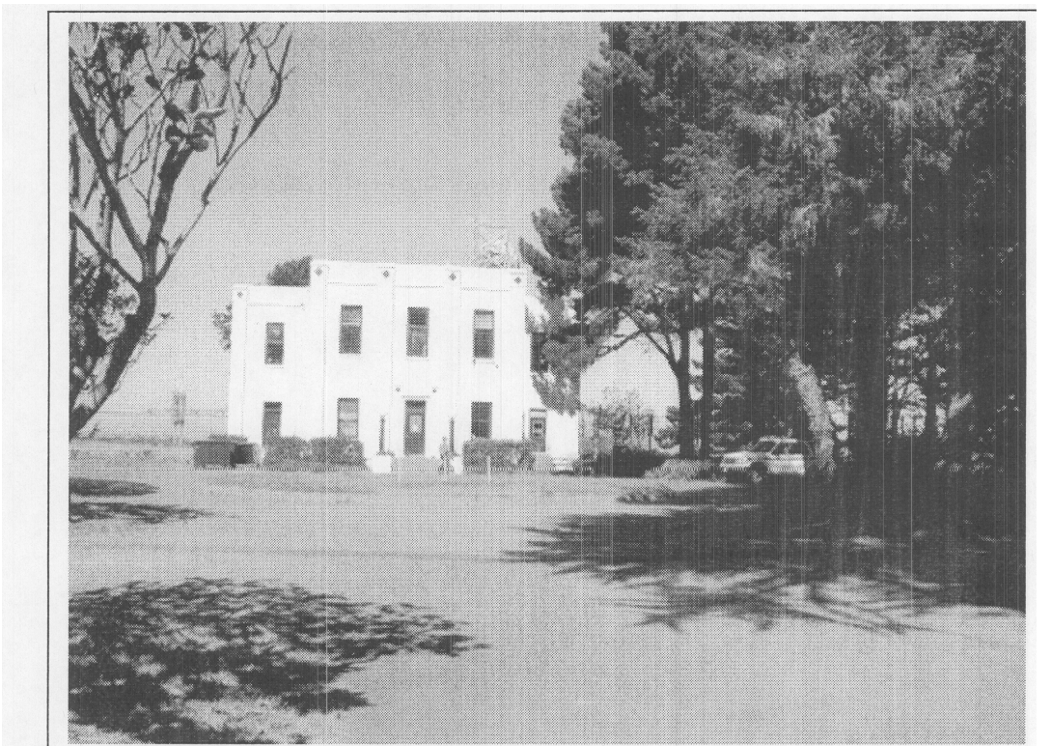

Figure 4. Location of the bat detector at the Education Center, Point Reyes National Seashore. The detector is located under the eve near the far window.

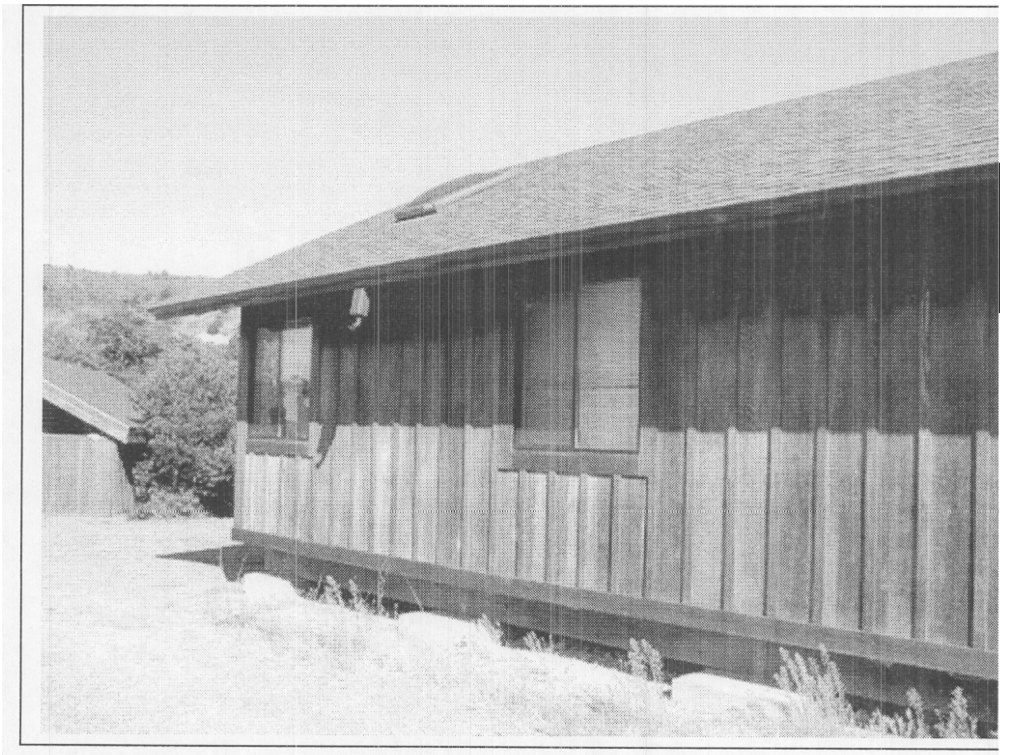

Figure 5. Location of the bat detector at Olema Marsh, Point Reyes National Seashore. The detector is located on the eve at the near corner of the house, just above the gate.

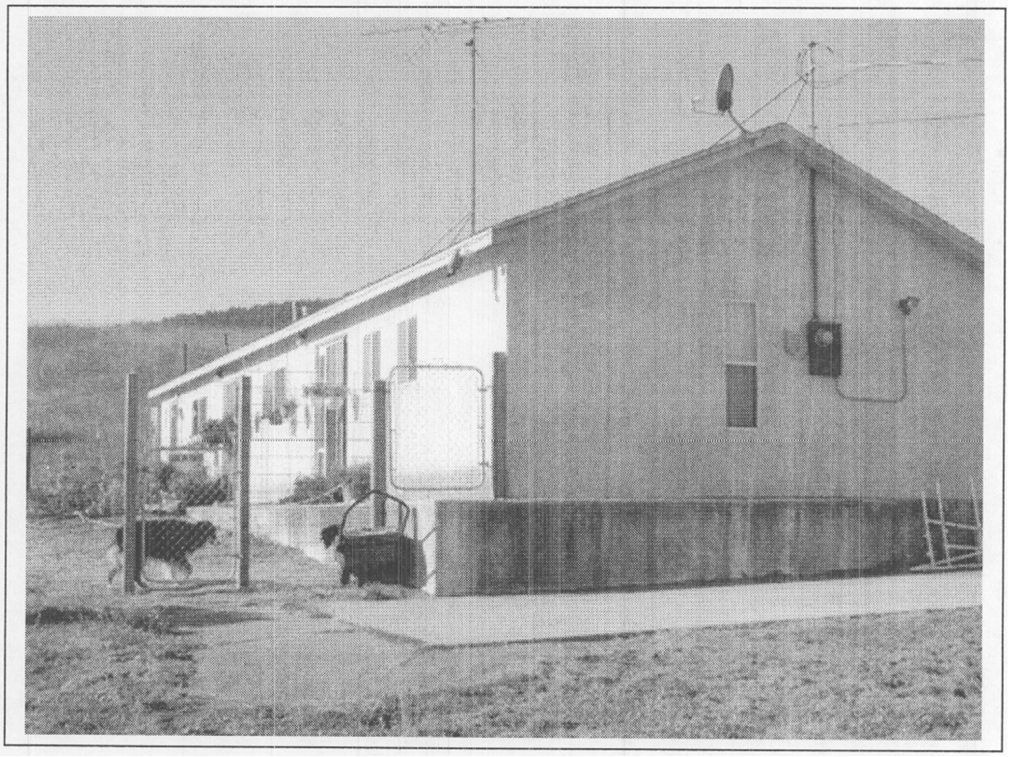

Figure 6. Location of the bat detector at Shallow Beach, adjacent to Point Reyes National Seashore. The detector is clearly visible near the bottom of the far right side of the deck.

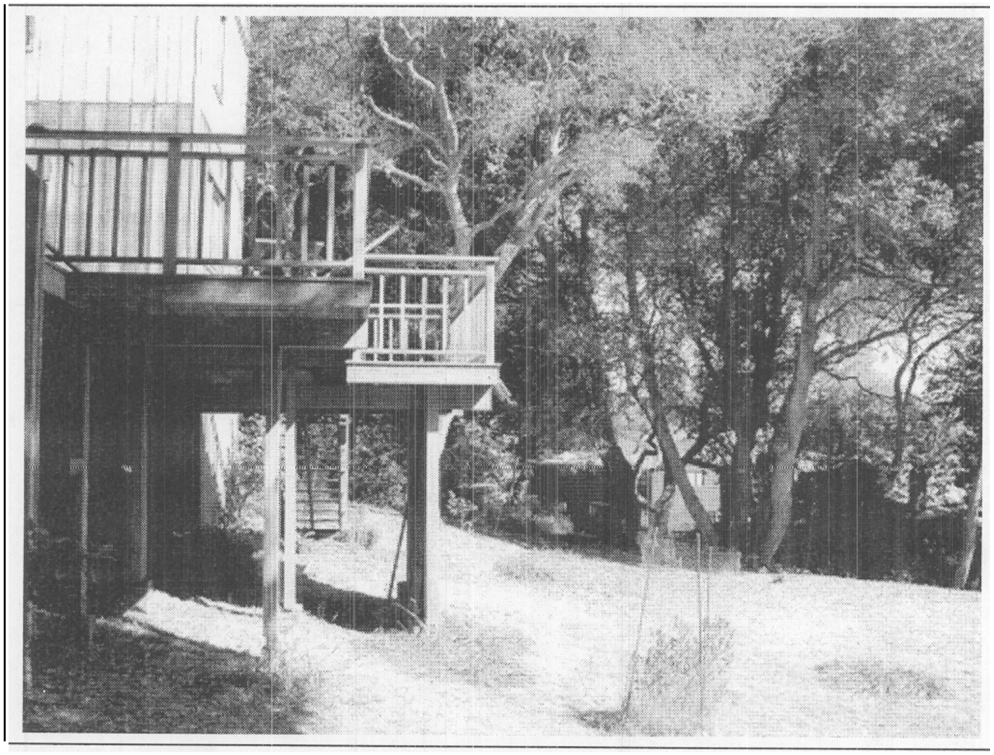

Figure 7. Sample recording of a Mexican free-tailed bat showing two vocalizations from a series of calls. The Y-axis is frequency (pitch) in kilohertz (kHz), and the X-axis along the bottom is time with each major mark denoting 25 milliseconds.

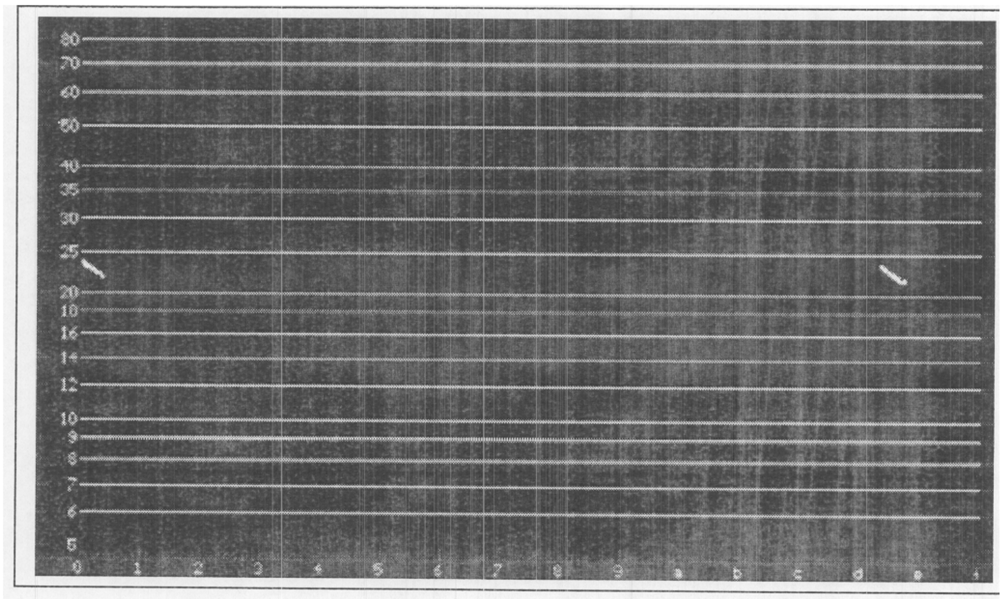

Figure 8. Sample recording of a Mexican free-tailed bat showing a series of vocalizations with the time between each call removed.

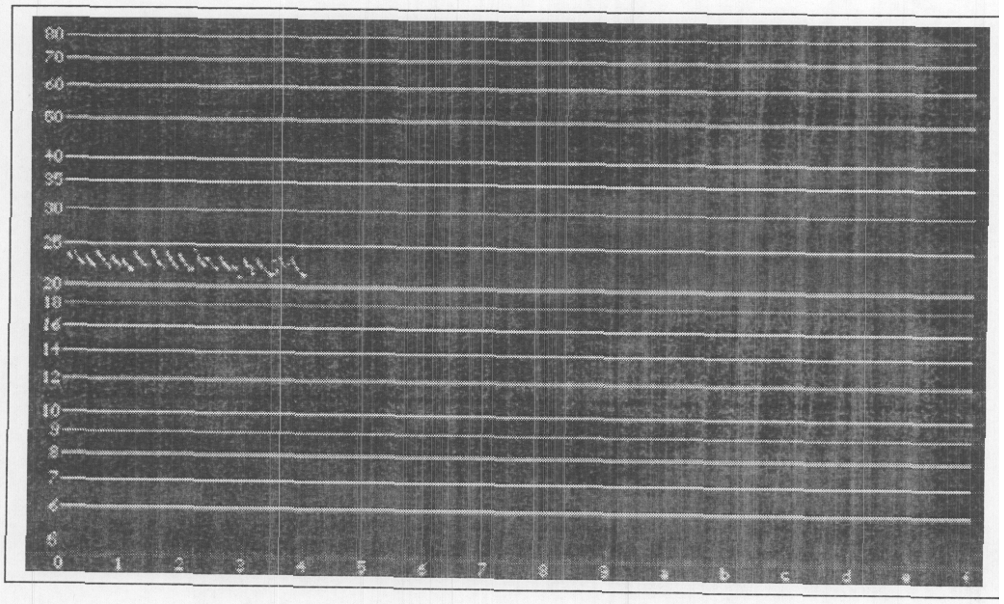

Figure 9. Sample vocalization of a silver-haired bat showing a series of vocalizations with the time between each call removed. Note that each vocalization sweeps down to about 20-25 kHz, but that the lowest frequency is quite variable.

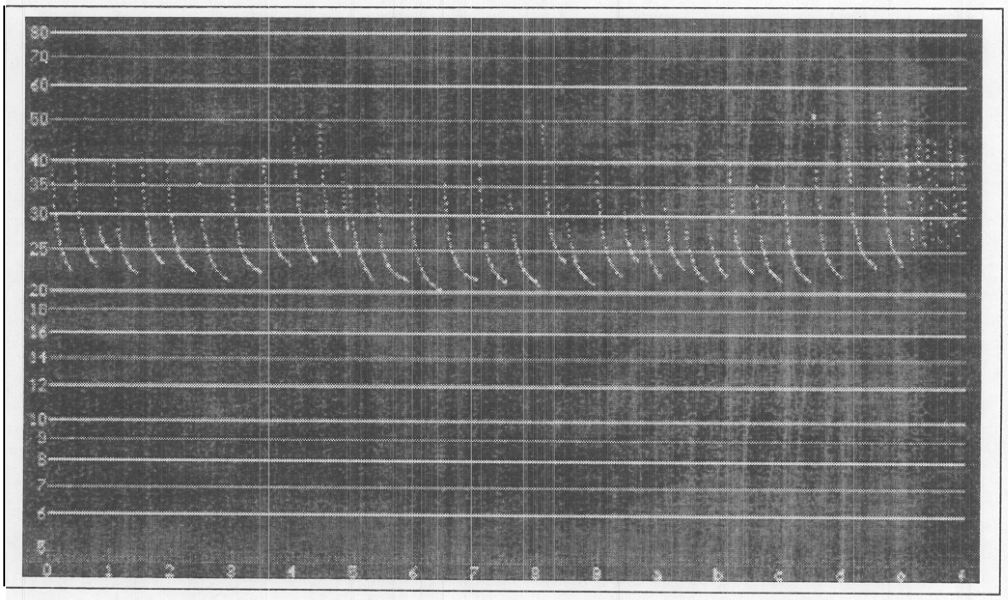

Figure 10. Sample vocalization of a big brown bat showing a series of vocalizations with the time between each call removed. Note that each vocalization sweeps down to about 25-30 kHz and the lowest frequency is fairly consistent from one call to another.

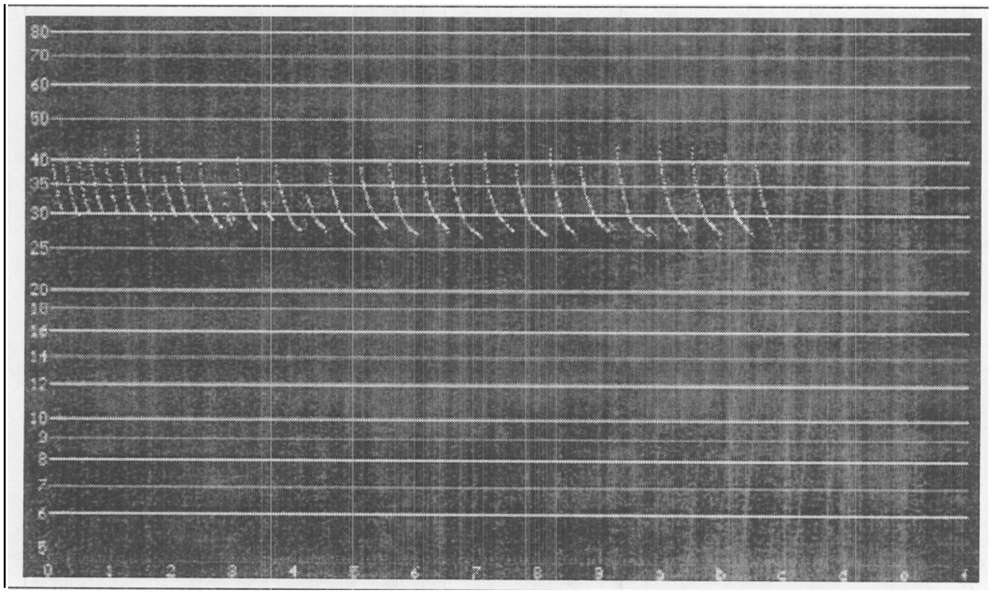

Figure 11. Number of calls detected per day at each of the 11 bat monitoring stations in 2002. Note that the Y-axis is limited to 3,000 and the number of calls at the Ed Center was more than double that number at 7,559.

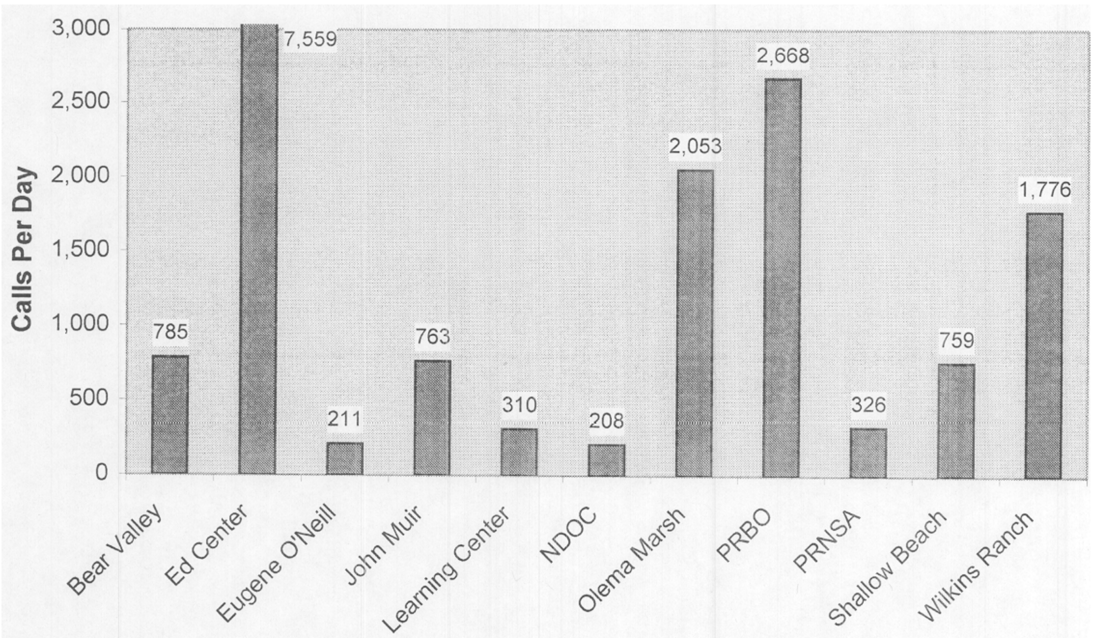

Figure 12. Number of red bat calls per day at each of the 11 monitoring sites in 2002.

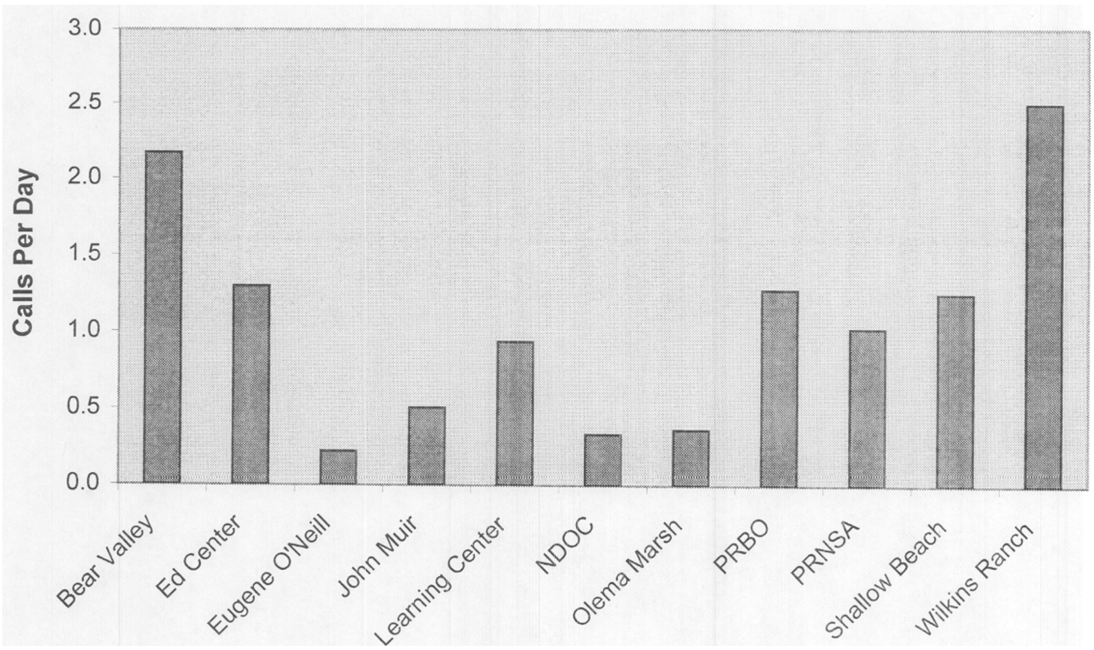

Figure 13. Number of hoary bat calls per day at each of the 11 monitoring sites in 2002.

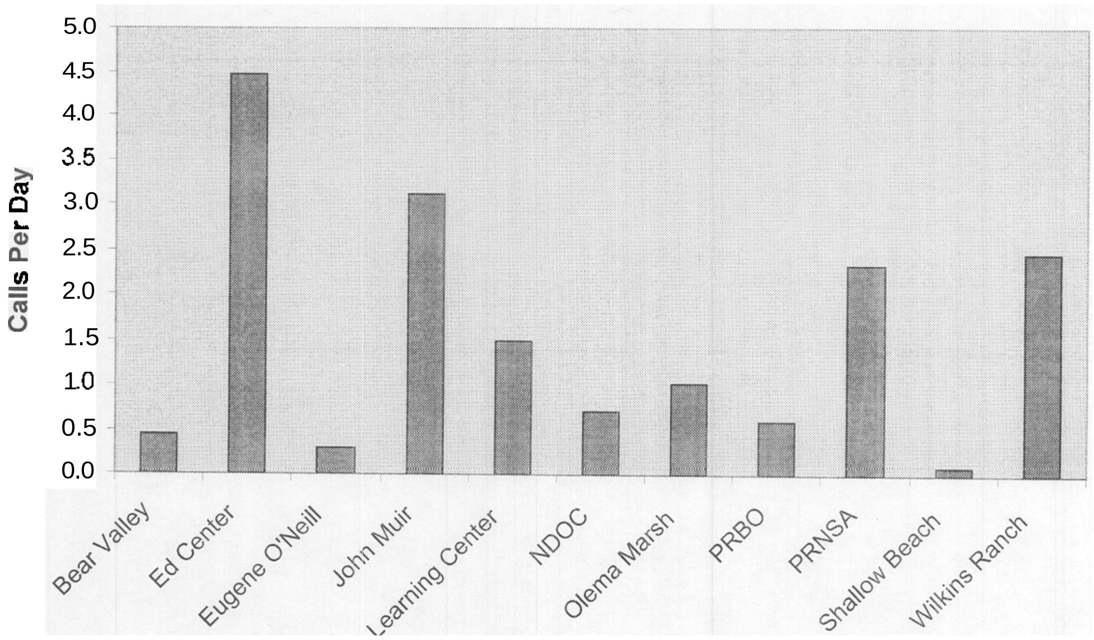

Figure 14. Number of big brown bat calls per day at each of the 11 monitoring sites in 2002

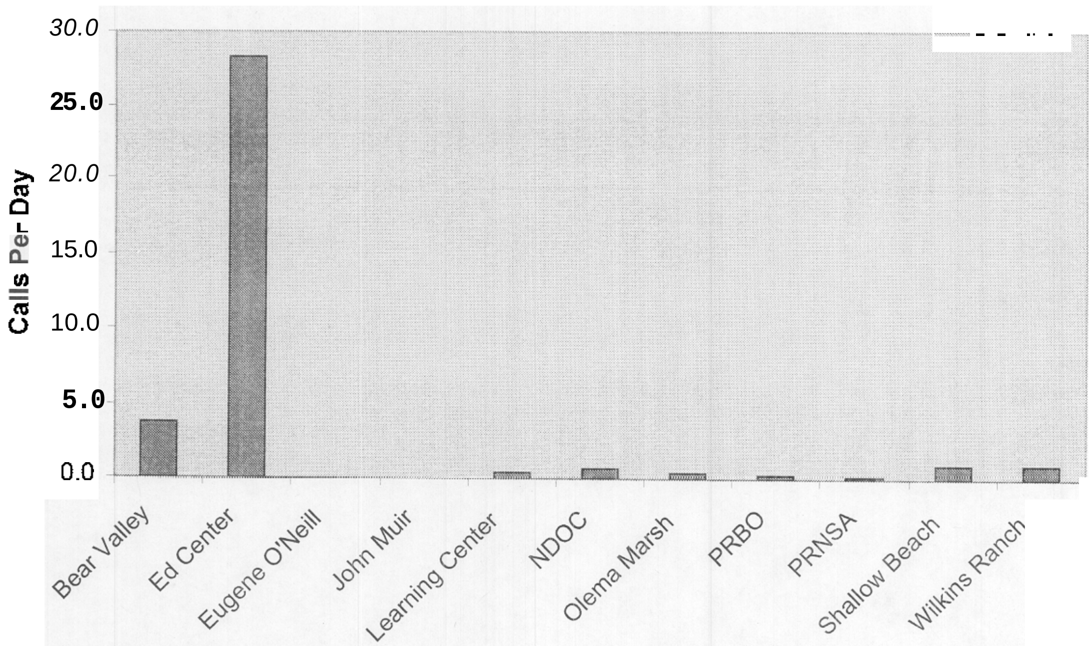

Figure 15. Number of silver-haired bat calls per day at each of the 11 monitoring sites in *2002.*

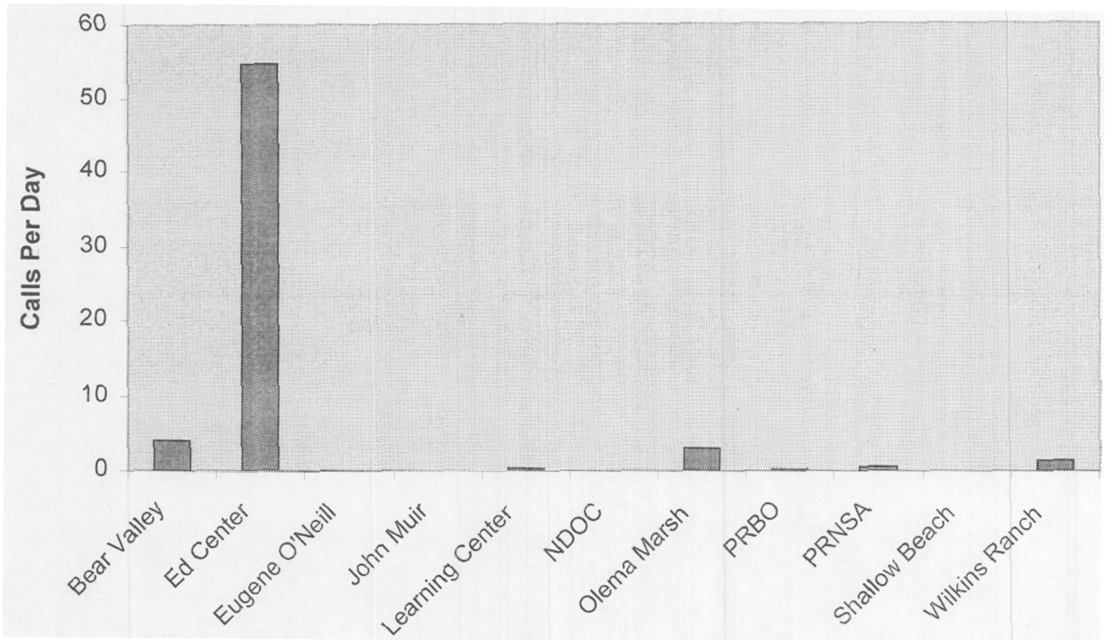

Figure 16. Number of Mexican free-tailed bat calls per day at each of the 11 monitoring sites in 2002.